



MAREX-NA

# International Space Station Amateur Radio SSTV System (SpaceCam)

## All Expedition Flights

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## User's Manual

### Warning

This manual relates to a stable software release, which is however not yet approved for flight.

**DRAFT**

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**Document Change Log**

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Doc. Issue	Date	Software Issue	Pages/Sections Affected	Reason for changes
Draft	April '01	Beta	All	First draft issue
1	March '02	RC1/B19	All	First formal issue. From next issue changes will be highlighted.

**PLEASE VERIFY ITEMS HIGHLIGHTED IN YELLOW  
THROUGHOUT THE DOCUMENT**

To be added before final version:

- considerations on SSC security
- access to network drives (USER Tab only ?)
- hardware connections details
- limit on maximum number of stored files ?

# 1 INTRODUCTION

## 1.1 Overview

SpaceCam is an advanced multimedia application software, which enables transmission and reception, via ordinary radio equipment, of drawings, pictures and still-video images. Other than an interface box and the radio equipment, no other external device is required to perform SpaceCam operations. The PC where SpaceCam is installed handles all data formatting and modulating tasks thanks to the audio interfaces embedded in a PC (i.e. audio board).

## 1.2 Scope of the document

This document constitutes the User Operating Manual for the SpaceCam application software and related hardware interfaces.

### 1.2.1 Document structure

This document is divided in 8 sections.

**Section 1** is this section, it provides references to material for a better understanding of this manual.

**Section 2** provides an overview of the SpaceCam system, that is the software environment and the hardware interfaces.

**Section 3** provides a “walk-around” of the user interface highlighting the major topics related to operating SpaceCam.

**Section 4** provides a detailed description of the different user interface controls available.

**Section 5** describes the basic operating modes of SpaceCam and the procedures for combined modes.

**Section 6** collects all technical details and provides the procedure to follow in order to install SpaceCam and prepare the related hardware for SSTV operations.

**Section 7** collects the credits, acknowledgements and copyright information.

**Section 8** provides a reference index.

## 1.3 Acronyms list

AAA	ARISS Audio Adapter
AMSAT	Amateur Radio Corporation
ARISS	Amateur Radio on International Space Station
BMP	Bitmap image file format
<b>CMP</b>	
CW	Continuous Wave, or Morse Code transmission
DIC	
DSP	Digital Signal Processor, or Processing
<b>DTMF</b>	
DSR	Data Set Ready (interface signal)
DTR	Data Terminal Ready (interface signal)
EMF	Enhanced MetaFile image file format
EPS	Enhanced PostScript
<b>FPX</b>	
GIF	Graphical Image Format image file format
ISS	International Space Station
JPG	Joint Photographic Group image file format
MAREX-NA	Manned Amateur Radio Experiment – North America
<b>NTSC</b>	
PCT	Image file format
PCX	Image file format
PNG	Image file format
PSD	Image file format
PTT	Push To Talk (interface signal to bring a transmitter on the air)
<b>RAS</b>	
RTS	Request To Send (interface signal)
RX	Receiver

SAREX	Space Amateur Radio Experiment
SSC	Station Support Computer
SSID	Secondary Station Identifier
SSTV	Slow Scan TeleVision
Sysop	System Operator
TGA, TARGA	Image file format
TIF, TIFF	Image file format
TX	Transmitter
UHF	Ultra High Frequency (for ARISS ops this is the 440 MHz, or 70cm, band)
VHF	Very High Frequency (for ARISS ops this is the 145 MHz, or 2m, band)
VOX	Voice Operated Switch
WMF	Windows Meta File image file format
WPG	
Wpm	Words Per Minute (symbol speed for CW operations)
XCVR	Transceiver

## 1.4 Applicable documents

To be completed

JSC-48529	International Space Station Command and Data Group Portable Onboard Computers
JSC-XXXXX	ISS-HAM SAREX Equipment
	ISS-HAM SAREX operations plan
	ISS Crew Equipment and/or Camcorder workbook

## 2 OVERVIEW

### 2.1 What is SpaceCam

SpaceCam is an entry-level PC-based Slow Scan Television system designed primarily to be used on board the International Space Station for transmission and reception of images via ISS-HAM radio links. The system supports multiple common SSTV transmission modes and it has been specifically designed to be accessible to as many stations as possible around the world.

SpaceCam has been designed by the MAREX-NA team, which developed and built the original proof-of-concept system. The proof-of-concept system was successfully flown on the Russian Space Station MIR (December 1998 until August 1999) and has proven the ability of the hardware design and it has taught how to make additional improvements for the next generation SSTV system for ISS.

On the ISS most of the original proof-of-concept hardware is replaced by already available IBM Thinkpad Portable Computers (SSC, Station Support Computer), while the radio equipment will be composed by the ISS-HAM Amateur Radio Station developed in the framework of the international ARISS project.

### 2.2 What are SSTV operations

Slow Scan TeleVision is a radio operating mode, widely used by the amateur radio community, which permits the transmission and the reception of images through conventional, narrow band, radio links. The technique is similar in principle to narrow band facsimile transmissions and it can be used on any radio band, from short waves to millimetre waves.

The image to be sent is scanned (mechanically or electronically) and transmitted as a continuously modulated audio signal. Synchronisation signals (typically audio tones) are embedded in the modulation in order to permit the reconstruction of the image at the other end of the link. The modulation speed is always kept to a minimum in order to operate on narrow band channels. These limitations reduce the number of line sent each second and, therefore, the transmission time of the related image. Typically a few tens of seconds are needed to transmit a full image.

Given the inherent characteristics of the transmission method (broadcast type) there is no error checking at the receiver side. Received images are therefore subjected to interference, noise and other disturbances, which may appear as dots or missing lines. MIR experience with the previous SpaceCam equipment, and Shuttle experience with the SAREX equipment, showed however that even basically equipped ground stations can receive good quality images despite the relatively low output power of amateur radio equipment aboard crewed missions.

The difference in the number of scan lines, in the modulation method and in other parameters gave birth to different SSTV modes. The SpaceCam software operated and recognises the most widely used of these SSTV modes. Like other amateur radio equipment operational rules, the operating mode of SpaceCam shall be coordinated by selected ground stations.

It shall be remarked that SSTV is an analogue communication mode (i.e., there is no digital transfer of information like in MPEG). Being of analogue nature, the SSTV transmission is subject to degradation due to noise and interference on the communication channel. This

factors can degrade the quality of images at the receiving end of the link. On the positive side, a full image can usually be completely received, even if heavily degraded.

## 2.3 What composes a SpaceCam system

The basic components of the SpaceCam project consist of a software application, which will run on any Station Support Computer (SSC) supporting Windows 95/98/NT, and an audio interface cable and adapter, the ARISS Audio Adapter, to be connected to the SSC.

The AAA will also interface to one of the two hand-held transceivers, which are part of the SAREX Amateur Radio Station equipment aboard the ISS. The SpaceCam project is plug-compatible with the SAREX equipment and will add two-way SSTV support to the other available operating modes, which are Voice and Packet.

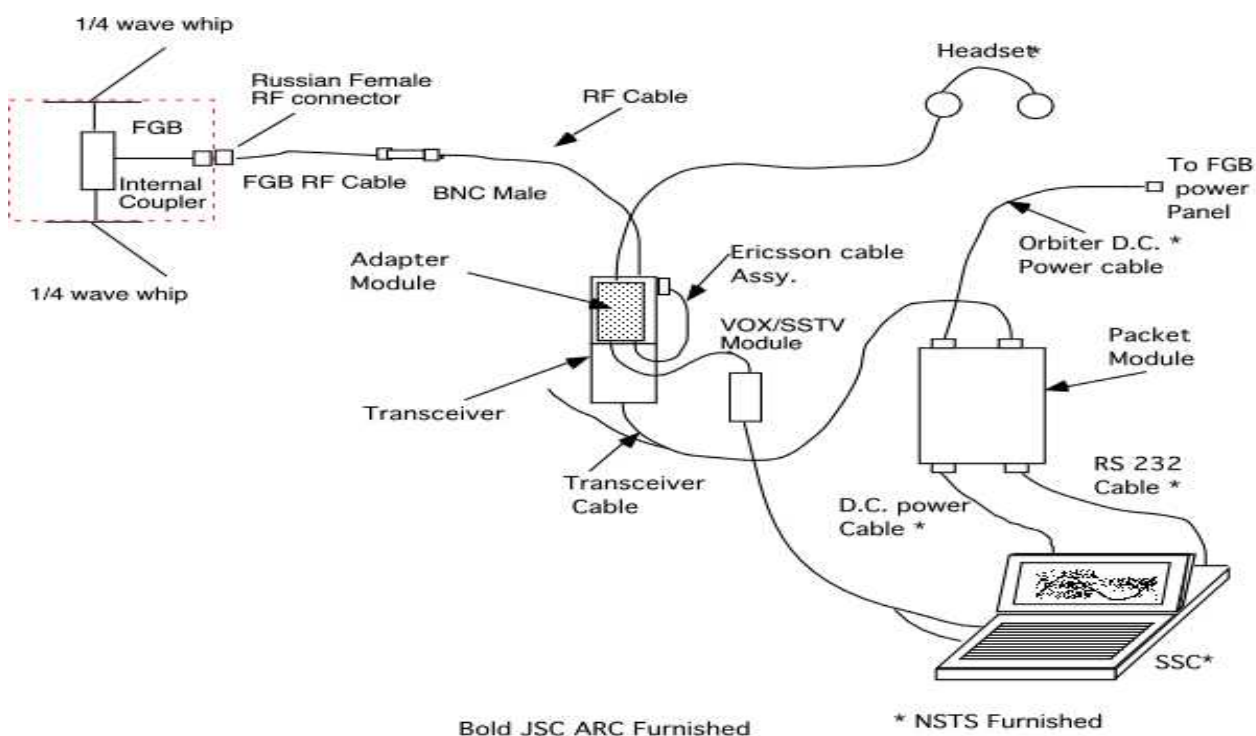


Fig. 2-1: ISS-HAM and SpaceCam overall set up

### 2.3.1 Laptop to Audio Adapter connections

The SSC (IBM-760) computer running SpaceCam will be connected to the SAREX 2 meter or 70 cm transceiver via the **SSTV/VOX Module** built by AMSAT-NA, which acts as audio isolation adapter.

The complete set of connections will require two or three (3) cable attachments to the SSC computer using existing connectors on the SSC computer: two for the audio input and output and one, optional, for transmit control. See section 6.7 for more details on the hardware.

The SSC computer connections will feed into the SpaceCam VOX/SSTV Module, which will provide DC isolation between the SSC and the SAREX transceiver and will provide automatic switching of the transceiver into transmit mode upon presence of an audio signal coming from the SSC.



The audio adapter will also convert the SSC the optional cable into a transmit control signal which is compatible with the ISS-HAM SAREX transceivers, in case the VOX option cannot be used.

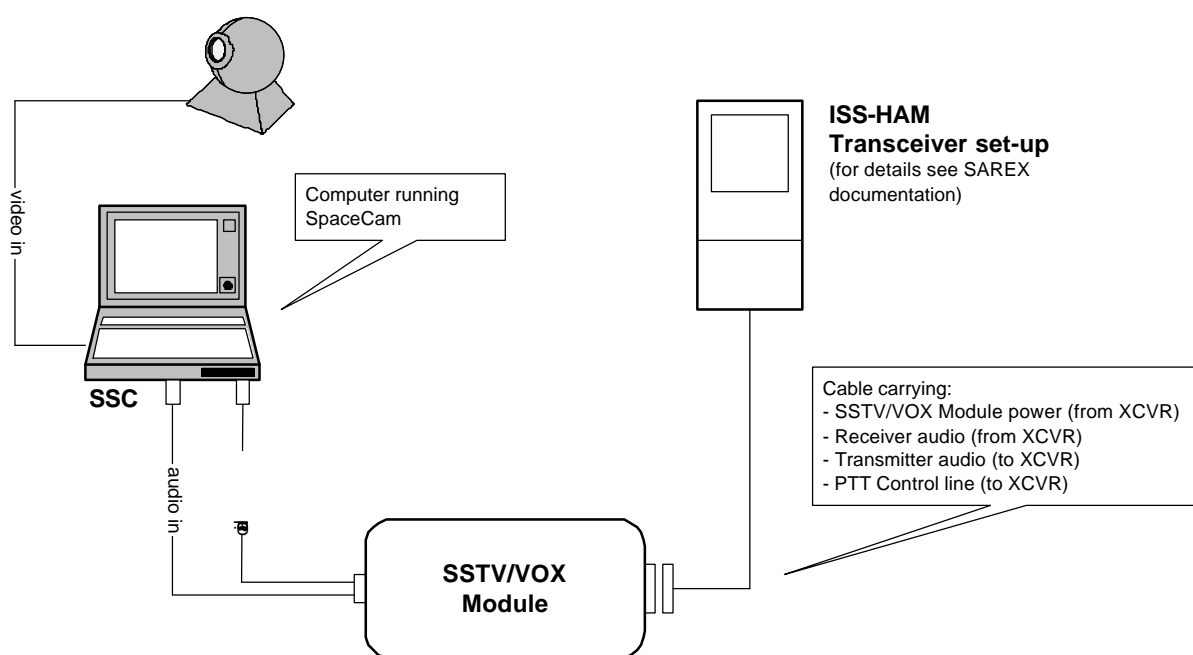
### 2.3.2 Radio equipments connection

The SpaceCam system is capable of operating on either the 2-metres (145 MHz) or the 70 centimetres (440 MHz) bands. The actual operating frequency and band for SSTV operations depends on SAREX equipment management plans (as defined by the ARISS consortium) and are out of the scope of this manual.

The preferred operational amateur radio band would however be the 2-meter band because of the limited amount of Doppler effect on this band. SAREX operations foresee a fixed operating frequency for ISS operators. Therefore ground operators shall compensate for Doppler shift in the received frequency as the ISS move in relation to them. Limiting the amount of Doppler shift will ease SSTV reception to kids, students and other less skilled ground operators maximising the reach of the system.

The audio interface box can therefore be connected to any of the two transceivers available in the ISS-HAM SAREX radio equipment, the VHF one or the UHF one. The chosen radio will need to be connected to one of the Amateur Radio external antenna ports on ISS.

Connection to the radio section, including power hook-ups, are described in the relevant crew operating manual for the ISS-HAM SAREX Equipment.



**Fig. 2-2: Details of interconnections between the SSC, the SSTV/VOX Module and the Radio equipment**

### 2.3.3 SpaceCam video and images sources

The SpaceCam software is designed to accept a live video input into the video port of the IBM-760 SSC computer. The live video will be displayed on the right hand preview window of SpaceCam (see chapter 3). Single screen shots are sampled from the live video stream and transmitted.

Any compatible NTSC RS-170 video source can be connected to the SSC video port, including a NTSC camera or Camcorder. This portion of the SpaceCam project will require manifesting of the SSC Video IN/OUT cable for the SSC computer. Refer to related documentation for detailed instruction.

SpaceCam can, however, be operated without any cameras attached. In fact, SpaceCam can be operated as a simple SSTV image repeater or be configured to sequentially transmit images previously stored on the SSC disk drive. Therefore ISS operators can, at their leisure, load images taken with any standard Digital Camera onto the SSC SpaceCam disk drive. Or they can even draw and store images on their own. SpaceCam can then be instructed to send selected stored images to Earth.

All the common image storage formats are supported, including JPEG, GIF, TIF and BMP.

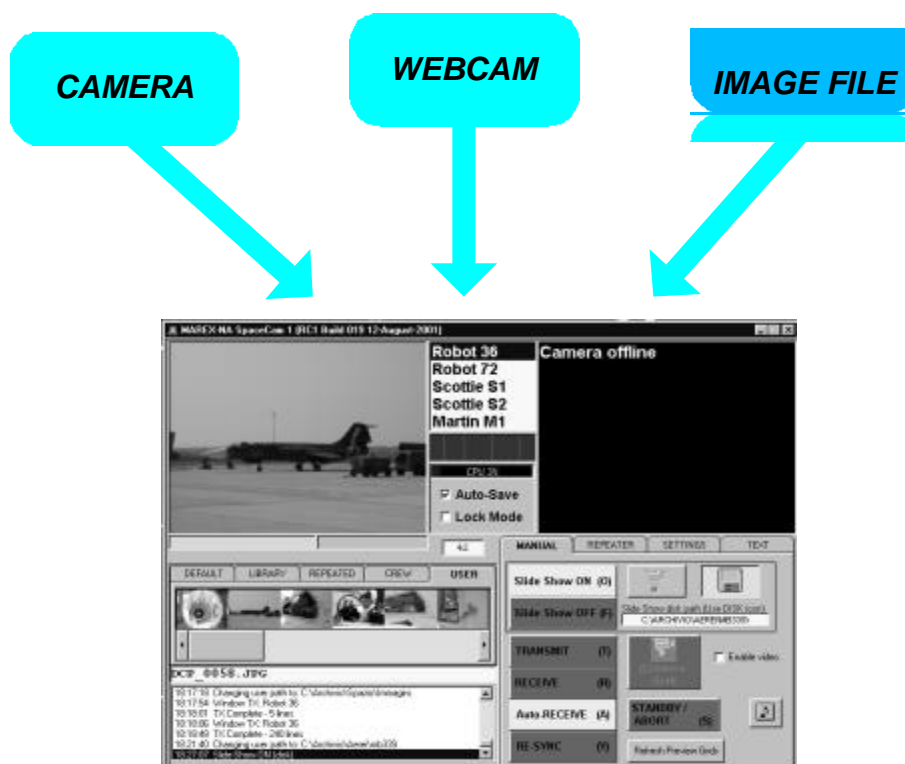


Fig. 2-4: Sources of images

## 2.4 What to do with SpaceCam

Given the previous experience on the MIR Space Station, the SpaceCam project for the ISS is set to become one of the most valuable educational tools available to the ARISS project.

The different operating modes enable many diverse utilisation scenarios, but the simplest one will foresee amateur ground stations receiving slow scan images from a camera left attached to an ISS laptop and pointing the inside of the ISS or to the outside through a porthole.

Alternatively the crew might collect images, label them, store them on disk, and have them replayed autonomously and continuously enabling ground stations to collect them in a few passages.

Another scenario foresees ground station taking the active part in the radio link and sending images to the crew aboard the ISS or even having the SpaceCam software acting as a space-borne repeater for ground operators.

As an additional feature, a ground station can remotely control SpaceCam operations when the program is running and the laptop is connected to a transceiver. The remote control is performed by means of DTMF audible tones sent over the radio link.

In conclusion it is evident that SpaceCam SSTV operations will permit full exploitation of the SAREX radio equipment even when the crew is too busy to perform ordinary voice contacts with ground stations. The ability to receive real time images or collect special images edited by the crew will offer great public outreach opportunities.

## 2.5 Overview of SpaceCam operating modes

Different operating modes have been defined for SpaceCam. The following table provides a summary of available modes.

	Transmission	Reception
Single image	Manual Mode	Manual Mode
Multiple images	Slide Show Mode	Auto-Receive Mode
	Repeater Mode	

### Transmission Manual Mode

The user can select a single image for transmission. The image source can be an image file or a frame grabbed from a video source.

### Transmission Slide Show Mode

The user can select a series of images to be transmitted continuously at a given interval. The image source can be a collection of image files or frames automatically grabbed from a video source.

### Reception Manual Mode

The user can manually force the acquisition of a single image. The received image is stored in the Default directory.

### Reception Auto-Receive Mode

The user put SpaceCam in an automatic acquisition mode and the program will start an image acquisition whenever an image preamble is recognised. Every received image is stored in the Default directory.

### Repeater Mode

This combined mode configures SpaceCam as a space-borne repeater of images sent by ground stations. SpaceCam, after the reception process is complete, re-transmits the received image. An option exists to retain received images in the Repeated directory.

## 2.6 Remote operations

Remote operations have been removed starting from this version of SpaceCam.

## 3 USER INTERFACE

This section provides a graphical walk-around of the SpaceCam software Graphical User Interface. Detailed explanations of available functionalities are provided in the next section.

The SpaceCam User Interface has been designed after careful operational considerations. For instance no standard drop-down menus are provided and all main controls are in view like in a hardware control panel. A summary of User Interface features are:

- Simple user interface, one single window panel used both to receive, manage and transmit images.
- Most image operations are based on fast 'drag and drop' or 'single click' operations. All controls can be rapidly accessed using powerful multi-tab function panels or single keyboard key-strokes (fast keys).
- Disk storage of images is handled by means of a 'thumbnail' tray, which provides small preview images of image files available on the hard disk as well as instant 'drag and drop' access to user's favourite directories.

### Caution

SpaceCam is designed to work on 800 x 600 or larger screen sizes.

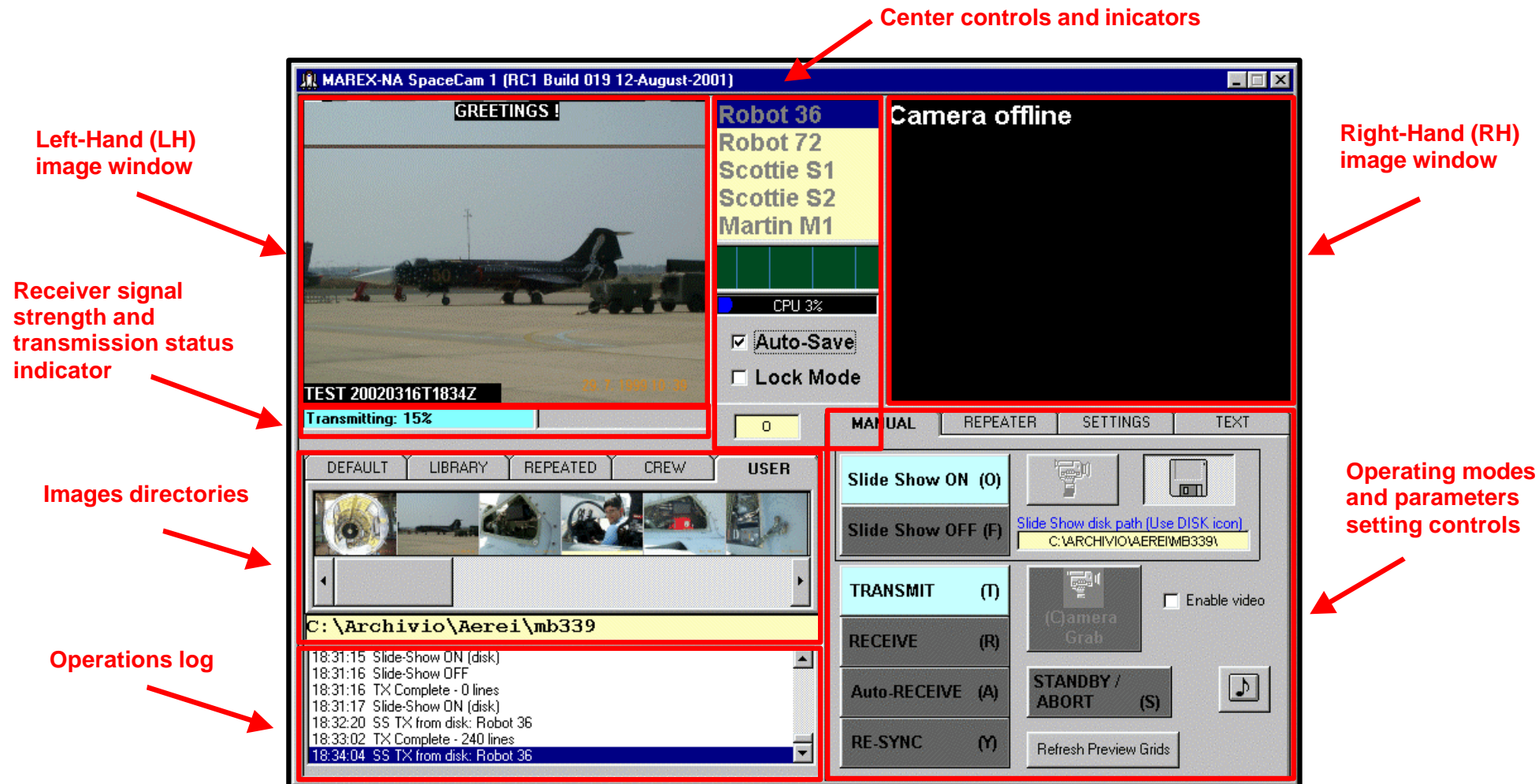
It is strongly suggested that you run Windows with your display settings set to use 'small fonts'. If you have trouble reading 'small fonts' the proper solution is to set your screen to a lower resolution. i.e. instead of 1024 x 768 on a 15" monitor you might try 800 x 600. If you use 'large fonts' Windows will scale up all of the screen elements including all controls and image boxes on the screen to accommodate the larger fonts. Unfortunately, 'fixed elements' such as actual bitmaps (SSTV pictures) will not be scaled up as it is important to maintain their original (actual) 'pixel' sizes. The effect of this is that you will end up with large forms on your screen, which will waste precious screen area. By using 'small fonts', controls become more compact and more screen area is available for 'real work'.

### Caution

Selection of operating parameters and, in certain instances, of operating times and modes, shall follow ground-established rules, which are also propagated to a vast community of ground users.

Only in certain instances the crew may act on their own on available parameters to improve the reception of ground transmitted images.

## SpaceCam application window





### LEFT-HAND IMAGE WINDOW

This window shows the image selected for transmission or the image being received. Full duplex operations (simultaneous transmit and receive) are not permitted.

During transmission a horizontal bar highlights the software scanning process of the selected image. A fixed text caption in the lower left corner reports the station ID and the transmission time-tag. Another, optional, text caption may be added for crew comments.

During reception the image is seen being composed line by line. A fixed text caption in the lower left corner of the image will be added to report the receive time-tag.

The size of this window can slightly increase to account for the number of lines used in SSTV mode selected.

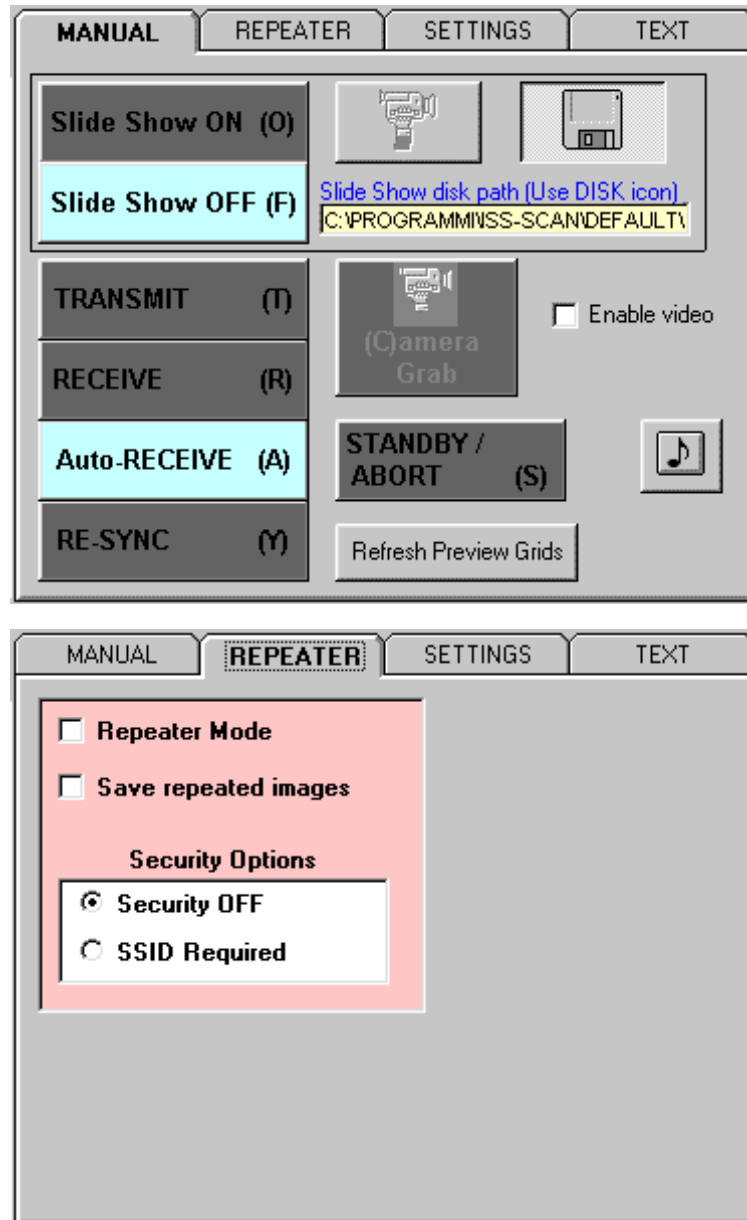


### RIGHT-HAND IMAGE WINDOW

This window shows a continuous sampling of video images from the selected video source.

When a transmission from the video source is started the image is frozen and transferred to the left-hand windows.





## MANUAL TAB

The MANUAL Tab panel provides controls for the basic transmit/receive operating modes of SpaceCam. In particular the Slide Show Mode can be selected as well as its image source (camera or file directory). Alternatively SpaceCam can be manually commanded to transmit a single image, again choosing between a frame grabbed from the camera or an image file stored in a directory.

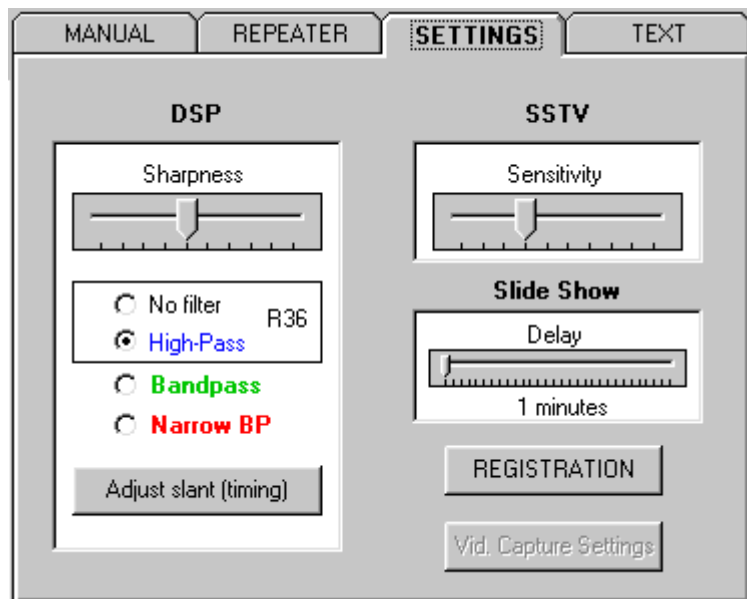
SpaceCam can also be placed in auto-receive mode or can be manually forced to start acquisition of an image.

When placed into Manual Mode, or Slide Show Mode, the SSTV system will stay in this mode until the user manually makes a change or the SSTV system receives a Sysop DTMF command.

## REPEATER TAB

The REPEATER Tab panel is used to configure all of SpaceCam Image Repeater options.

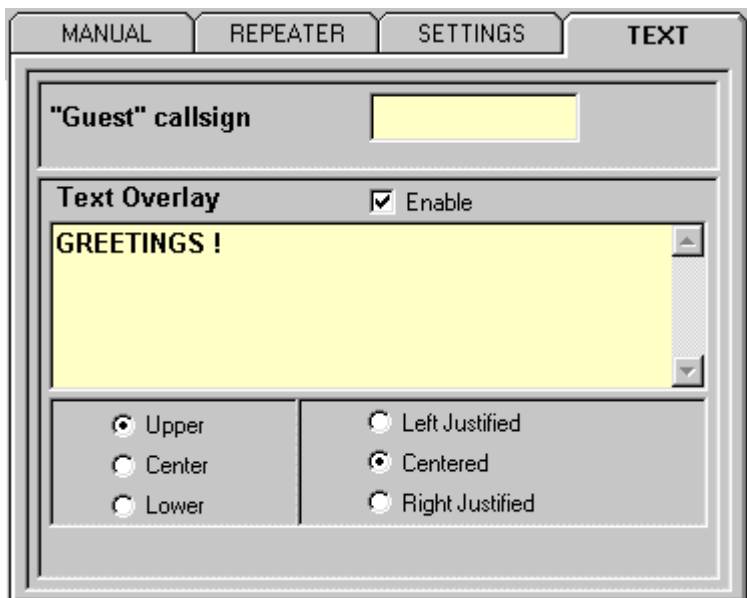
When placed into REPEATER MODE, the SSTV system will stay in this mode until the user manually makes a change or the SSTV system receives a Sysop DTMF command.



### SETTINGS TAB

The SETTINGS Tab panel is used to configure several parameters mainly related to SpaceCam receiving algorithms, including DSP receiver filter controls and sensitivities.

The Settings tab is also used to configure SpaceCam Slide Show timings.



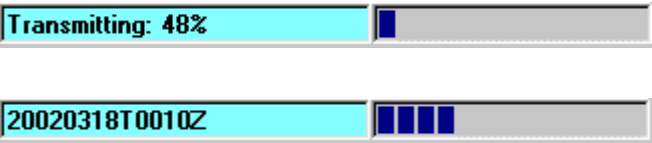
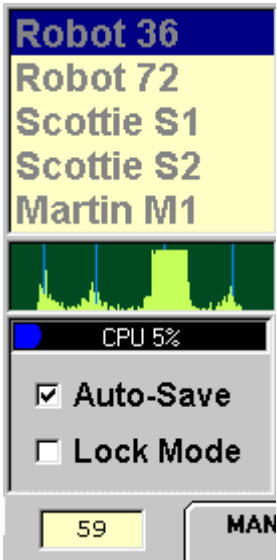
### TEXT TAB

The TEXT Tab panel is used to enter ASCII text messages, which will be overlaid on images transmitted from SpaceCam (if the relevant option is enabled). The free format text field supports all common ASCII characters. The text overlay position can also be specified.

In addition it is possible to specify the callsign of a "guest" radio operator which is using the ISS radio station (whose callsign always appear in the lower left corner of the transmitted image).

It is to be noted that images repeated via SpaceCam while in Repeater Mode, will not have the text overlaid.





### CENTRAL CONTROLS

This area collects different controls.

The uppermost selection list is used to select the desired SSTV signal standard, for transmission, and to display the SSTV mode automatically recognised by SpaceCam during reception of an image.

Below is the Spectral Display, which provides additional information about the quality of received signals.

The CPU usage bar provides indication of system resources utilisation.

Two checkbox controls enable the Auto-Save feature for received images and permits locking the SSTV standard selection control on the panel to avoid its inadvertent activation.

Below the above-mentioned controls, and when the Slide Show Mode is selected, a text box provides indication of how many seconds are due before start the transmission of the next image.

### STATUS INDICATOR

These controls are situated below the Left-Hand window and perform two roles depending whether SpaceCam is transmitting or receiving an image.

While transmitting the controls provide indication of the status, as percentage of the full image scan, of the transmission process.

While receiving the controls provide the time-tag generated at the beginning of reception and an indication of the audio signal level at SpaceCam input.



## IMAGE DIRECTORIES

The Image Directories multiple tabbed control enables the user to select different “collections” of images. Upon selection of a “collection”, its content is shown as a scrollable ‘thumbnail’ preview of the available images.

Five “collections” type are available for selection. The first four correspond to fixed hard disk directories. The last collection offers the option to select any accessible directory (by double clicking on the User Tab itself).

**DEFAULT** – Collection of JPG images auto-saved during reception. These images can in turn be used for transmission.

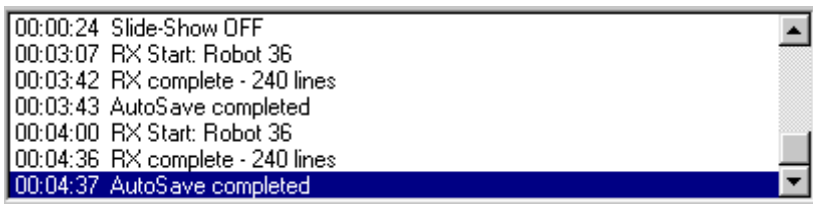
**LIBRARY** – Collection of “working” images gathered from different sources.

**REPEATED** – Collection of auto-saved images received during Repeater Mode operations.

**CREW** – Collection of personal images that is preferable to keep separate from the others.

**USER** – Collection of images found in a user selected directory.

In Manual Mode the user will double-click on a “thumbnail” to select an image for transmission. In Slide Show Mode all the images in the selected collection will be transmitted in turn.



## OPERATIONS LOG

The Operations Log is a scrollable text area which provides a continuously updated listing of SpaceCam operations, events and user actions.

All logged items are time stamped.

## 4 CONTROLS DESCRIPTION

### 4.1 Introduction

In this section a detailed description is given of every element of the user interface. The description follows a hierarchical listing of available controls.

The SpaceCam application is started by accessing the relevant shortcut in the Windows Start Menu (under the Programs item). Upon start-up an initialisation screen is displayed for a limited time before being substituted by the main application window.



### 4.2 Description

#### 4.2.1 *Application's window frame*

Speaking at application level, SpaceCam is implemented in single, fixed size, movable window. The window has no menu bar for every actions is performed by means of other kind of controls (mainly buttons).

The window frame hosts two standard buttons.

##### 4.2.1.1 Minimise button

The Minimise button reduces the application to a button item in the Windows application bar. Clicking on the button item restore the application window to its original size and position on the desktop.

#### 4.2.1.2 Close button

The Close button terminates the application instantly. Some details of the current application state are saved in the SpaceCam configuration file so that they can be re-instated at the next activation of SpaceCam.

### **4.2.2 SpaceCam controls**

#### 4.2.2.1 Left-hand image window

This window is used to present:

- an image being received or just received;
- an image selected (from “thumbnails tray” or “grabbed” from video source) for transmission;
- a start-up image which also notifies the callsign of the station which is using SpaceCam.

#### 4.2.2.2 Right-hand image window

This window is used to present, continuously, live video images from the attached video source.

#### 4.2.2.3 Status indicators

These are two progress-bar type indicators situated below the Left-hand Window.

##### 4.2.2.3.1 Tx status indicator

This indicator is active whenever an image transmission occurs. It provides a text indication of the preamble transmission phase and a percentage of image transmitted during the image scanning process.

##### 4.2.2.3.2 Rx signal strength indicator

This indicator is active whenever there is an audio signal at the PC audio input. During image acquisition it provides a continuous relative indication of the strength level of the received signal.

#### 4.2.2.4 Central controls

The central controls are mainly dedicated to SSTV mode selection and additional status information.

##### 4.2.2.4.1 SSTV Mode selection list

This list provides a mean to select a different SSTV mode other than the default one (which is Robot 36). The selected mode applies to image transmission for during reception the SSTV receiver selects automatically a mode compatible with the standard used by a ground station.

##### 4.2.2.4.2 Receiver spectral display

This dedicated control present a continuous sampling of the spectral content of the signal received at the audio input. The overall span of the control is about 2500 Hz and the vertical lines correspond to the following audio frequencies:

- 1200 Hz, which is the Sync frequency (start of each image scan line);
- 1500 Hz, which corresponds to the black colour;

- 1900 Hz which corresponds to the 50% gray colour;
- 2300 Hz, which corresponds to the white colour.

#### 4.2.2.4.3 CPU usage indicator bar

This provides a percentage and progress-bar like indication of CPU resource usage. The progress-bar changes colour from green to yellow to red to highlight situation when available resources are scarce. Since CPU resources are shared by SpaceCam, the operating system and possibly other application the user has the option to alter the system configuration in order to maintain application performances.

#### 4.2.2.4.4 Auto-Save checkbox

Selecting this checkbox enables the automatic storage (in the DEFAULT collection) of received images. Storage of 'repeated' images is handled by another dedicated checkbox.

#### 4.2.2.4.5 Lock Mode checkbox

Selecting this checkbox will hinder any subsequent tentative to change the SSTV mode selection. **Does it work ?**

#### 4.2.2.4.6 Slide show delay indicator

This small text indicator appears at the bottom of the central controls, in correspondence with the centre of the application window, only when Slide Show Mode is selected On. When visible it indicates the number of seconds before the next Slide Show image transmission.

### 4.2.2.5 Multi-tab panels control: image directory/"thumbnails" selector

This multiple tab panel selector is for selecting images available on the PC's disk. Four collections are stored in fixed directories. A fifth is associated to images found in a user selected directory.

#### 4.2.2.5.1 DEFAULT Tab

This tab shows images contained in the DEFAULT directory created, during the installation of SpaceCam, in the application base directory (usually C:\Program Files\ISS-SCAN).

This directory is used to store images received by SpaceCam (when the Auto Save option is checked). Images stored can be used for further re-transmissions.

#### 4.2.2.5.2 LIBRARY Tab

This tab shows images contained in the LIBRARY directory created, during the installation of SpaceCam, in the application base directory (usually C:\Program Files\ISS-SCAN).

This directory is provided to collect reference images gathered from different sources for use during SSTV operations.

#### 4.2.2.5.3 REPEATED Tab

This tab shows images contained in the REPEATED directory created, during the installation of SpaceCam, in the application base directory (usually C:\Program Files\ISS-SCAN).

This directory is used to store images received by SpaceCam and subsequently repeated (when the Repeater Mode is On and the checkbox relevant to repeated images saving is selected).

#### 4.2.2.5.4 CREW Tab

This tab shows images contained in the CREW directory created, during the installation of SpaceCam, in the application base directory (usually C:\Program Files\ISS-SCAN).

This directory is provided as an additional storage area for personal images, which are preferably kept separate from others.

#### 4.2.2.5.5 USER Tab

This tab shows images contained in the directory selected by the user by double-clicking on this tab label. Any recognised image found in the selected directory will be shown in the "thumbnails".

#### 4.2.2.5.6 "Thumbnails" tray

By selecting one of the Tabs, the "thumbnails" tray shows a small preview of the images contained in the corresponding directory.

Double-clicking on any image shown in the "thumbnails" tray, a copy of the image is transferred to the Left-Hand Window in view of a possible transmission.

#### 4.2.2.6 Image directory pathname indicator

This single line text area shows the selected USER Tab directory, from the above "thumbnail" tray, or the filename of a selected image.

The relevant image filename is also shown if the mouse cursor is passed in front of each image in the "thumbnails" tray.

#### 4.2.2.7 Operations log text area

This multi-line text area is used as a scrolling log of events. Internal events, events caused by user actions, autonomous operations and errors, are all displayed in this area as one line, time tagged comments.

The content of this log is reset each time that SpaceCam is executed. When the number of log lines exceed the vertical dimension of the text area, a vertical scrollbar is shown on the left side of the area.

#### 4.2.2.8 Multi-tab panels control: SpaceCam operations

This multiple tab panel selector is for controlling SpaceCam SSTV operations and settings.

##### 4.2.2.8.1 MANUAL Tab

###### *4.2.2.8.1.1 Slide Show On button*

This button activates the Slide Show Mode.

###### *4.2.2.8.1.2 Slide Show Off button*

This button deactivates the Slide Show Mode.

###### *4.2.2.8.1.3 Camera select button*

This button selects the video source as image source during Slide Show Mode. The button is enabled only when a valid video source has been recognised and enabled.

#### 4.2.2.8.1.4 *Disk image select button*

This button selects the currently selected image collection (shown in the “thumbnails” tray) as image source during Slide Show Mode.

#### 4.2.2.8.1.5 *Disk directory text area*

The text area below the previous buttons shows the directory correspondent to the selected image collection.

#### 4.2.2.8.1.6 *Transmit button*

This button suspends any current operation and starts transmitting the image shown in the Left-Hand Window (Manual Transmit Mode) using the selected SSTV mode (central controls).

#### 4.2.2.8.1.7 *Receive button*

This button suspends any current operation and starts receiving an image (Manual Receive Mode) showing the results in the Left-Hand Window. If the mode is not recognised from the incoming audio signal, then the selected SSTV mode (central controls) is used for the SSTV receiver process.

#### 4.2.2.8.1.8 *Auto Receive button*

This button activate the Auto-Receive Mode.

#### 4.2.2.8.1.9 *Re-Sync button*

This button permits to force a re-synchronisation of the SSTV receiver with the incoming signal. It is always active but is effective only while a reception is in progress.

#### 4.2.2.8.1.10 *Enable video checkbox*

This checkbox is to enable a video source once it has been connected with the PC on which SpaceCam is running. If the video source is correctly recognised, images appear in the Right-Hand Window; otherwise an error message is logged in the Operations Log Text Area.

#### 4.2.2.8.1.11 *Camera grab button*

This button takes a ‘snapshot’ of a video frame, as shown from the enabled video source in the Right Hand Window, and copies it on the Left Hand Window. This action is taken to manually sample and transmit the camera output. This button is enabled only if a valid video source is enabled and recognised.

#### 4.2.2.8.1.12 *Stand-by / Abort button*

This button stop unconditionally any ongoing operating mode.

#### 4.2.2.8.1.13 *Refresh previews button*

This button is to force an update of the content shown in the “thumbnails” trays.

#### 4.2.2.8.1.14 *Musical note icon button*

This button is used to force the transmission of an audio tone to access ground based repeaters. THIS BUTTON IS FOR TEST PURPOSES ONLY AND WILL NOT BE AVAILABLE IN THE FLIGHT VERSION.

#### 4.2.2.8.2 REPEATER Tab

##### 4.2.2.8.2.1 Repeater Mode checkbox

This checkbox is to select and enable Repeater Mode. Repeater Mode can be engaged in Auto-Receive Mode or in Slide Show Mode or both.

##### 4.2.2.8.2.2 Save Repeated Images checkbox

This checkbox enables the option of saving repeated images in the REPEATED collection.

##### 4.2.2.8.2.3 Security radio buttons

These radio buttons, (Security OFF / SSID Required) mutually exclusive with each other, enables, or disables, the security option for Repeater Mode. If enabled the image to be repeated shall have a valid SSID encoded in its leader.

#### 4.2.2.8.3 SETTINGS Tab

##### 4.2.2.8.3.1 DSP – Sharpness slider

This slider control permits the adjustment of the sharpness of the SSTV receiver.

##### 4.2.2.8.3.2 DSP – Filter radio buttons

These radio buttons, (No Filter / High Pass / Band Pass / Narrow BP) mutually exclusive with each other, selects different filtering options for the SSTV receiver. The first two options are suggested for the Robot 36 SSTV Mode (default one).

##### 4.2.2.8.3.3 DSP – Adjust Slant (timing) button

This button opens a form containing two slider controls for the separate adjustment of Tx and Rx sampling frequencies.

##### 4.2.2.8.3.4 SSTV – Sensitivity slider

This slider control permits the adjustment of the sensitivity of the SSTV receiver.

##### 4.2.2.8.3.5 Slide Show – Delay slider

This slider control permits the adjustment of the delay between two successive Slide Show Mode transmissions.

##### 4.2.2.8.3.6 Registration button

This button opens a form containing information about the registration of the SpaceCam application. This includes the default callsign used for SpaceCam operations.

##### 4.2.2.8.3.7 Vid. Capture settings button

This button opens a dedicated form, which permits the adjustment of different video source parameters. This button is enabled only when a video source is enabled and recognised.

#### 4.2.2.8.4 TEXT Tab

##### 4.2.2.8.4.1 Guest callsign text area

This single line text area is reserved to specify a “guest” callsign different from that used during SpaceCam operations. This callsign substitutes the default one in the basic



callsign/time-tag message normally displayed. The content of this text area is preserved from one activation of SpaceCam to the next.

#### *4.2.2.8.4.2 Message text area*

This multi line text area is to enter a text message to be superimposed to transmitted images in addition to the basic callsign/time-tag message normally displayed. The content of this text area is preserved from one activation of SpaceCam to the next.

#### *4.2.2.8.4.3 Enable text overlay checkbox*

This check box is to enable the automatic addition of the Guest callsign and the Text Overlay in future image transmissions.

#### *4.2.2.8.4.4 Vertical Positioning radio buttons*

These radio buttons, (Upper / Center / Lower) mutually exclusive with each other, selects the vertical position of the additional text overlay.

#### *4.2.2.8.4.5 Horizontal Positioning radio buttons*

These radio buttons, (Left Justified / Center / Right Justified) mutually exclusive with each other, selects the horizontal position and layout of the additional text overlay.

## 5 OPERATING MODES

### 5.1 Generalities

The SpaceCam SSTV system can be used basically for sending and receiving low-resolution colour images. The processes of sending and receiving are performed line by line, each line content being modulated as audio tones. During transmission the image to be sent is shown in the LH Image Window and a horizontal line scrolling over it will highlight the scanning process. During reception, the image being received is shown composed line by line in the LH Image Window.

Before transmitting an image, a station identifier (typically the callsign of the ISS Amateur Radio Station) is transmitted in CW, modulated as an audio tone. Ground stations sending images will typically embed their callsign inside a data packet (SSID) modulated in the first line of the SSTV signal.

SpaceCam has the option to automatically store received SSTV images. The images will be saved on the SSC disk drive in a specific directory. The crew can disable this AutoSave option at any time. The amount of disk space required to store each SSTV image varies depending on the amount of detail contained in the image. There is a Disk-Save feature in SpaceCam software, which will limit the amount of disk space used by the SSTV images.

Images received are saved as JPG (or JPEG) file formats. Image to be transmitted can be selected between a number of multiple formats, practically all the known ones.

Images can have text superimposed. Received images will have superimposed a line of text containing the time stamp with the reception time and the callsign extracted from the embedded SSID. Transmitted images will have superimposed the ISS amateur radio station callsign and the time stamp with the transmission time. Users can additionally specify one or more lines of text to be superimposed as well to transmitted images.

Different standards exist for transmission of images through radio links. The amateur community utilises a number of them and SpaceCam is able to operate with the most widely used ones.

#### Caution

Selection of operating parameters and, in certain instances, of operating times and modes, shall follow ground-established rules, which are also propagated to a vast community of ground users.

Only in certain instances the crew may act on their own on available parameters to improve the reception of ground transmitted images.

#### 5.1.1 SSTV Transmit modes

SpaceCam supports the following SSTV transmit modes:

Mode name	Transmission time (sec)	No. of lines
Robot-36	36	240
Robot-72	72	240

Scottie-S1	90	256
Scottie-S2	94	256
Martin-M1	90	256

Please note that the transmission time is not linked to the number of lines.

After SpaceCam program initialisation, the video mode **Robot-36** becomes the default mode used for transmission. This mode is chosen as default because it requires the shortest amount of image transmission time (36 seconds).

The crew can manually override the Robot-36 mode selection and select any one of the other supported transmit modes.

It is not necessary for SpaceCam to support all other SSTV transmit modes currently available. The additional transmit modes would only increase the complexity of the user interface and would not add any value to space-borne applications.

### 5.1.2 SSTV Receive modes

SpaceCam supports the following SSTV receive modes:

#### Supported Receive SSTV modes

Robot-36, Robot-72

Scottie-S1, Scottie-S2

Martin-M1, Martin-M2

AVT-90, AVT-94

Additional Receive only modes may be supported.

The SpaceCam program receives all of the most common SSTV modes. When SpaceCam is placed in Auto-Receive mode, it will automatically detect and select the proper image mode.

### 5.1.3 Image Formats

SpaceCam will read most of the common image storage formats including:

#### Raster formats

JPG, GIF, TIF, BMP, PCX, FPX, DIC, PNG, TGA, RAS, WPG, PCT, CMP

#### Vector formats

WMF, PSD, EPS

## 5.2 SpaceCam Operating Modes

SpaceCam operating modes are summarised in the following table:

	Transmission	Reception
Single image	Manual Mode	Manual Mode
Multiple images	Slide Show Mode	Auto-Receive Mode
	Repeater Mode	

Every time the SpaceCam software program is started it is configured as follows:

**Robot-36 SSTV standard with Lock Mode disabled**

**Auto-Receive Mode ON with Auto Save enabled**

**Slide Show Mode OFF**

**Repeater Mode OFF**

**DEFAULT image collection selected**

**DSP and other SETTINGS as used last time**

**TEXT setting as used last time**

**VIDEO source as used last time**

These settings correspond to manual TX operations (user can select an image and command its one-shot transmission) and automatic RX operations.

### Note

To terminate at any time any operating mode it is sufficient to act on the STANDBY/ABORT button and bring the application in the Stand-by state.

### 5.2.1 Radio station Callsign

The Callsign of the radio station using SpaceCam is defined during program installation and can be modified by means of a dedicated setting control (see paragraph 5.3). This Callsign is shown on the initialisation screen, which appears at program start-up.

It is possible to add a “guest” callsign in order to handle cases when not ISS resident astronauts are willing to send images (see paragraph 5.3).

The SSID (Secondary Station Identifier) is a special option, which is supported by most SSTV vendors. The sending station's Callsign is stored digitally in a line of SSTV data. This data can be read and translated into a standard Amateur Radio call sign. **If the sending station sent a valid SSID packet, the Callsign will be permanently added to the text at the end of the image.** If the SSID is not sent, or it is received garbled, the SSID information will just be omitted.

### 5.2.2 Manual Stand-by

The STANDBY/ABORT button is similar to an Abort or Stop button.

Acting on the STANDBY button activates the Standby Mode (not shown in the previous table) which permits to maintain the application running without any operating mode being active.

Upon activation the Standby Mode will stop the active mode at the moment of activation as well as resetting the Repeater Mode option. The STANDBY button will be highlighted to indicate the suspension of SSTV operations.

### **5.2.3 Manual transmission of single images**

#### **5.2.3.1 Transmit a Single Image from Camera**

With the Video source enabled (checkbox), the camera output is replayed in the RH window.

1. Acting on the Camera Grab icon button the video image will be frozen and the snapshot transferred to the LH window. It is not possible to grab an image if a transmission, or a reception, is underway.
2. Acting on the TRANSMIT button, the program will begin transmitting the image in the LH window.
3. When the transmission of the image has completed, SpaceCam will always return to the Auto-Receive Mode.

A transmission can be terminated at any time by acting on the STANDBY/ABORT button.

Upon commanding a manual transmission any other active mode (Slide Show or Repeater) is terminated.

#### **5.2.3.2 Transmit a Single Image from Disk**

The image source will be any of the images stored in the five collections showed in the "thumbnails" tray. The first four collections have associated a fixed directory (and purpose), the fifth collection, USER, can be associated to any system disk directory by double-clicking on the User Tab.

1. By double-clicking on any of the images shown in the "thumbnails" tray, the selected image file is read from disk and a copy of the image will appear in the LH window. Until the transmission is not started It is possible to change image at any time. It is not possible to grab an image if a transmission, or a reception, is underway.
2. Acting on the TRANSMIT button, the program will begin transmitting the image in the LH window.
3. When the transmission of the image has completed, SpaceCam will always return to the Auto-Receive Mode.

A transmission can be terminated at any time by acting on the STANDBY/ABORT button.

Upon commanding a manual transmission any other active mode (Slide Show or Repeater) is terminated.

#### **5.2.3.3 Manual transmission timeline**

This timeline applies to all transmission modes for each image transmission.

<b>Time</b>	<b>Sequence of events</b>
+0 sec	Preamble transmission starts with generation of a fixed tone (to key the transceiver into transmit by means of VOX)
+2 sec	Station ID transmission begins, sent as CW tone (12 wpm)

+4 sec	After ID completed, picture Transmission starts immediately using SSTV Robot-36 mode.
+36 sec (*)	The transmission ends nominally
<b>42 sec</b>	<b>Total timeline time</b>

(\*) The transmission time of an image depends on the selected SSTV mode. See 5.1.1 for details. The total timeline time shall therefore revised accordingly to the selection made.

#### **5.2.4 Automatic transmission of multiple images**

Slide Show Mode operating settings are discussed in section 5.3.

Slide Show Mode can operate in conjunction with Repeater Mode and Auto-Receive Mode.

##### **5.2.4.1 Slide Show Mode from camera**

With the Video source enabled (checkbox), the camera output is replayed in the RH window.

1. By selecting the Camera source (with the dedicated icon button within the Slide Show frame) Slide Show Mode will periodically grab images from the video source and transmit them.
2. Acting on the Slide Show On button the Slide Show Mode is activated and a delay counter will be displayed at the centre of the window (at the bottom of the central controls panel). Slide Show Mode can be selected even if a transmission/reception is underway but its operations will start only when the current process reaches an end.
3. When the delay counter reaches zero a frame is grabbed from the video source, transferred to the LH window, and the transmission begun.
4. When the transmission of the current image has completed, the delay counter will be reset to its initial value and the process will repeat with a new grabbed image.

Slide Show Mode can be terminated at any time by acting on the STANDBY/ABORT button or by initiating a Manual Transmission or Manual Reception.

##### **5.2.4.2 Slide Show Mode from disk**

The image source will be any of the images stored in the five collections showed in the "thumbnails" tray. The first four collections have associated a fixed directory (and purpose), the fifth collection, USER, can be associated to any system disk directory by double-clicking on the User Tab.

Slide Show Mode iterates through the image collection by filename following the alphabetic order.

1. By selecting the Disk source (with the dedicated icon button within the Slide Show frame) Slide Show Mode will cycle through the images present in the collection and transmit them. By double-clicking on any of the images shown in the "thumbnails" tray, the selected image file is read from disk and a copy of the image will appear in the LH window, but this has no effect on Slide Show operations.
2. Acting on the Slide Show On button the Slide Show Mode is activated and a delay counter will be displayed at the centre of the window (at the bottom of the central controls panel). Slide Show Mode can be selected even if a transmission/reception is underway but its operations will start only when the current process reaches an end. Until an image transmission is not started, It is possible to change the selected image collection at will. Changing collection will reset the image index to the first image in the collection.

3. When the delay counter reaches zero a frame is grabbed from the video source, transferred to the LH window, and the transmission begun.
4. When the transmission of the current image has completed, the delay counter will be reset to its initial value and the process will repeat with the next image in the collection. At the end of the collection the process will repeat again from the first image.

Slide Show Mode can be terminated at any time by acting on the STANDBY/ABORT button or by initiating a Manual Transmission or Manual Reception.

#### 5.2.4.3 Slide Show Mode Timeline

This timeline applies for a single image transmission in the Slide Show Mode and it is repeated for each new image.

Time	Sequence of events
+0 sec	A fixed delay of N minutes (*) is applied.
+N*60 sec(*)	Preamble transmission start with generation of a fixed tone (to key the transceiver into transmit by means of VOX)
+(N*60 + 2) sec	Station ID transmission begins, sent as CW tone (12 wpm)
+(N*60 + 4) sec	After ID completed, picture Transmission starts immediately using SSTV Robot-36 mode.
+(N*60 + 36) sec (**)	The transmission ends nominally.
<b>N*60 + 42 sec</b>	<b>Total timeline time</b>

(\*) The number of minutes used for the intra-images delay ranges from 1 to 30.

(\*\*) The transmission time of an image depends on the selected SSTV mode. See 5.1.1 for details. The total timeline time shall therefore revised accordingly to the selection made.

#### Note

Slide Show Mode can be used to transmit a single "beacon-like" image. In order to perform such an operation, store the image in a single separate directory and select the directory as USER collection. Given the presence of a single image in the directory, Slide Show Mode will continuously transmit the same image.

### 5.2.5 Manual reception of single images

#### 5.2.5.1 Manual Receive Mode

This mode is used to force SpaceCam to start decoding an SSTV image, which is being received too weakly to activate the Auto-Receive mode.

1. Acting on the RECEIVE button will immediately activate the reception process and the SSTV receiver will try to compose an image. The SSTV receiver will assume the incoming image is encoded according to the last SSTV mode selected.
2. During reception the result of the SSTV receiver process will be shown in the LH window as an image which is composed line by line.

3. Image reception ends when the expected number of lines for the selected mode is reached. The received image is automatically stored in the DEFAULT collection and its filename will be composed with the current system date and time (i.e.: "2002-03-19 221532.JPG").
4. When the transmission of the image has completed, SpaceCam will always switch to the Auto-Receive Mode.

Manual Reception Mode can be terminated at any time by acting on the STANDBY/ABORT button or by initiating a Manual Transmission or by switching to Auto-Receive Mode. The partially received image will not be saved to disk.

#### 5.2.5.2 Manual Re-Sync

The RE-SYNC button is used during image reception to manually attempt to stabilise a poorly aligned image.

Each image line has a coded tone which marks its beginning. Re-sync'ing the reception will force the SSTV receiver to re-evaluate the receive signal for a better lock on these tones.

### **5.2.6 Automatic reception of multiple images**

#### 5.2.6.1 Auto Receive Mode

This is the default mode with the SSTV receiver ready to acquire images.

1. Acting on the Auto-RECEIVE button the software will switch to Auto receive Mode. This mode is also reached at the end of a manual reception and at the end of a manual transmission.
2. Whenever a signal is present at the audio input of the SpaceCam SSC, the software will attempt to determine which SSTV Mode is being used by the sender. If the signal is recognised and stable, the SSTV receiver will be activated to start decoding the image.
3. During reception the result of the SSTV receiver process will be shown in the LH window as an image which is composed line by line.
4. Image reception ends when the expected number of lines for the selected mode is reached.
5. The received image is automatically stored in the DEFAULT collection and its filename will be composed with the current system date and time (i.e.: "2002-03-19 221532.JPG").
6. When the transmission of the image has completed, SpaceCam will return to the Auto-Receive Mode.

Image reception and Auto Receive Mode can be terminated at any time by acting on the STANDBY/ABORT button or by initiating a Manual Transmission. The partially received image will not be saved to disk.

#### 5.2.6.2 Manual Re-Sync

The RE-SYNC button is used during image reception to manually attempt to stabilise a poorly aligned image.

Each image line has a coded tone which marks its beginning. Re-sync'ing the reception will force the SSTV receiver to re-evaluate the receive signal for a better lock on these tones.

### **5.2.7 Auto Receive and Slide Show combined operations**

It is possible to select both Auto Receive Mode and Slide Show Mode at the same time.



### 5.2.8 Repeater Mode operations

Repeater Mode is an operational modification of the Auto Receive Mode. It applies even if Auto Receive is selected while Slide Show Mode is also selected.

By activating the Repeater Mode, automatically received images are sent immediately broadcast providing ground station a mean to share images at great distances (within the current ISS coverage area). An option exists to store repeated images on board.

#### 5.2.8.1 Repeater access control

To gain access to the repeater ground stations shall send a fixed tone for at least 2 seconds in order to activate the image receive, store and re-transmit process.

Access to the repeater can also be restricted by means of security controls. By enabling the SSID Required Security Option (as opposed to the Security Off option), ground stations shall encode their callsign, as SSID, in the image to be sent.

**Please verify: the callsign received is stored, or validated, or is it checked against a fixed list (how do you edit it) in order for the process to continue?**

#### 5.2.8.2 Basic Repeater Mode Operation

The program is operating in Auto-Receive Mode and Slide Show transmit Mode is Off.

1. Whenever a signal is present at the audio input of the SpaceCam SSC, the software will attempt to determine which SSTV Mode is being used by the sender. If the signal is recognised and stable, the SSTV receiver will be activated to start decoding the image.
2. During reception the result of the SSTV receiver process will be shown in the LH window as an image which is composed line by line.
3. Image reception ends when the expected number of lines for the selected mode is reached.
4. If the Save Repeated Images option is set (checkbox) then the received image is automatically stored in the REPEATED collection and its filename will be composed with the current system date and time (i.e.: "2002-03-19 221532.JPG").
5. After reception the transmission process begins and the received image, still in the LH window, is re-transmitted.
6. When the transmission of the image has completed, SpaceCam will return to the Auto-Receive Mode.

Repeater Mode operations can be terminated at any time by acting on the STANDBY/ABORT button or by initiating a Manual Transmission or a Manual Reception.

#### 5.2.8.3 Slide Show Repeater Mode Operation

The program is operating in Auto-Receive Mode and Slide Show transmit Mode is On.

1. During the delay period between the transmission of two subsequent images, the software is ready to receive images. Whenever a signal is present at the audio input of the SpaceCam SSC, the software will attempt to determine which SSTV Mode is being used by the sender. If the signal is recognised and stable, the SSTV receiver will be activated to start decoding the image and the Slide Show Mode will be suspended.
2. During reception the result of the SSTV receiver process will be shown in the LH window as an image which is composed line by line.
3. Image reception ends when the expected number of lines for the selected mode is reached.

4. If the Save Repeated Images option is set (checkbox) then the received image is automatically stored in the REPEATED collection and its filename will be composed with the current system date and time (i.e.: "2002-03-19 221532.JPG").
5. After reception the transmission process begins and the received image, still in the LH window, is re-transmitted.
6. When the transmission of the image has completed, SpaceCam will return to the Auto-Receive Mode and the Slide Show Mode will be resumed.

Repeater Mode operations can be terminated at any time by acting on the STANDBY/ABORT button or by initiating a Manual Transmission or a Manual Reception.

With reference to the Repeater Mode Timeline (see next paragraph) it shall be noted that images transmitted as part of the Slide Show Mode cycle will include the 'RRR' message before the Station ID (sent as CW) in order to notify ground stations of the availability of the repeater. This should avoid interfering tentatives, by ground stations, to try and activate the SSTV repeater.

#### 5.2.8.4 Repeater Mode timeline

This timeline applies to all transmission modes for each image transmission.

Time	Sequence of events
<b>First phase</b>	
+0	Repeater tone meeting requirements is received. If Slide Show is On the its operation is suspended.  SpaceCam waits for ground station to resume receive mode, then
+5 sec	Transmission of letter 'K' as a CW tone (10 wpm).  Ground station has 10 seconds after 'K' is transmitted to begin an SSTV transmission.
+10 sec (max.)	If the delay is longer than 10 sec, or no transmission is made, nothing is repeated and normal operations (Auto-Receive and Slide Show if it was On) resume.
<b>Second phase</b>	
+0	SpaceCam begins to receive the SSTV signal. Basing on security option it determines whether the signal qualifies to be repeated.
+36 (*) sec	End of reception (Robot 36 mode assumption). If the image didn't qualify then the received image will not be repeated and normal operations (Auto-Receive and Slide Show if it was On) resume.  If the image qualify a separation delay is applied.
+1 sec	Preamble transmission starts with generation of a fixed tone (to key the transceiver into transmit by means of VOX).
+2 sec	Transmission of 'RRR' + Station ID begins, sent as CW tone (12 wpm).
+4 sec	After ID transmission has completed, picture Transmission starts immediately using SSTV Robot-36 mode.

+36 (*) sec	The transmission ends nominally. The program returns to Auto Receive Mode and, if it was On, Slide Show Mode is resumed.
<b>79 sec</b>	<b>Total second phase timeline time</b>

(\*) The transmission time of an image depends on the selected SSTV mode. See 5.1.1 for details. The total timeline time shall therefore be revised accordingly to the mode used by the ground station and by the SSTV mode chosen by the user.

**Is there any delay imposed between the retransmission of one image and the possibility to send another from ground?**

## 5.3 SpaceCam operation settings

### 5.3.1 DSP and SSTV settings

SSTV receive and transmit operations are DSP algorithms based. Receive algorithms in particular are sensitive to certain parameters that could require adjustment while in operating conditions. Dedicated controls are therefore provided to enable crew adjustment of these parameters.

#### Note

It shall be remarked that varying parameters values shall be performed only with a clear understanding of their purposes. Default values are already optimised for the majority of operating condition as they can be foreseen in ground simulations.

The parameters concerning SSTV operations are the following:

#### Sharpness

This parameters adjusts **TBD**.

A single slider control permits varying values between 0 and 9.

#### Filter selection

This combination of “radio” buttons permits to choose between different filtering options to be applied before reception sampling is performed **TBC**. Available settings are:

No filter – no filter is applied.

High Pass – high frequency components are removed.

Band Pass – the receiver pass band is restricted.

Narrow Band Pass – the receiver pass band is restricted even more.

The first two options are suggested for Robot 36 SSTV mode operations.

#### Slant adjust

This button opens window which presents two sliders, one for adjusting the RX sampling frequency and the other for TX sampling frequency.

The purpose of this adjustment is **TBD**.

#### Sensitivity

This parameters adjusts **TBD**.

A single slider control permits varying values between 0 and 9.

### 5.3.2 Other settings

In the same tab panel it is possible to control the delay which the program will interpose between two subsequent Slide Show Mode transmissions.

**Slide Show Delay** This slider control permits to specify a delay ranging from 1 to 30 minutes.

### 5.3.3 Text overlays

Each operating mode will superimpose at least one text message on each processed SSTV image. This applies both to images transmitted and received. Additional multi-line text overlays may be edited by the user by means of the TEXT Tab panel and superimposed to transmitted images.

All kind of text overlays are always shown in the Left-Hand Window as soon as they are generated (that is at the beginning of a transmission or reception). The text overlay modify only the content of the Left\_Hand Window and does not modify the content of the original image file.

#### Note

Text overlays applies to all transmitted images as long as the option is enabled.

#### 5.3.3.1 Normal Reception of Images

**At the bottom-left of each received image** SpaceCam will superimpose the following information whose text is arranged in a single line:

CALLSIGN TIMETAG

where the CALLSIGN of the sender station is extracted from the SSID (see section 5.1) embedded in the video signal (if this information is corrupted or missing then the CALLSIGN will be omitted);

and TIMETAG is a string providing date and time of the begin of the reception (specified in the format **YYYYMMDDTHHMMZ**).

Example with Callsign extracted from SSID:



Example without Callsign:



### 5.3.3.2 Normal Transmission of Images

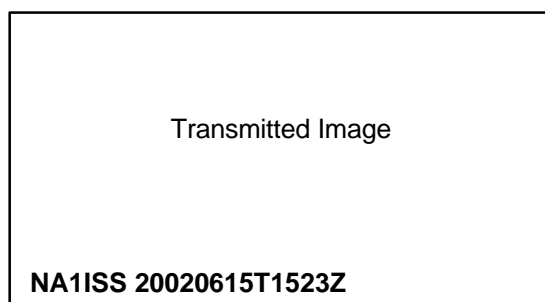
**At the bottom-left of each transmitted image** SpaceCam will superimpose, before transmitting, the following information whose text is arranged in a single line:

CALLSIGN TIMETAG

where the CALLSIGN is that of the local station as programmed in the registration of SpaceCam (without registration the callsign is TEST);

and TIMETAG is a string providing date and time of the begin of the transmission (specified in the format YYYYMMDDTHHMMZ).

Example:



Please note that if the image selected for transmission were received previously from ground, then its receive text overlay will be hidden from the transmission text overlay.

This text overlay applies to all transmitted images, including those managed by Slide Show Mode and repeater Mode.

### 5.3.3.3 Transmission of Repeated Images

**At the bottom-left of each repeated image** SpaceCam will superimpose, before transmitting, the following information whose text is arranged in a single line:

CALLSIGN TIMETAG

where the CALLSIGN is that of the local station as programmed in the registration of SpaceCam (without registration the callsign is TEST);

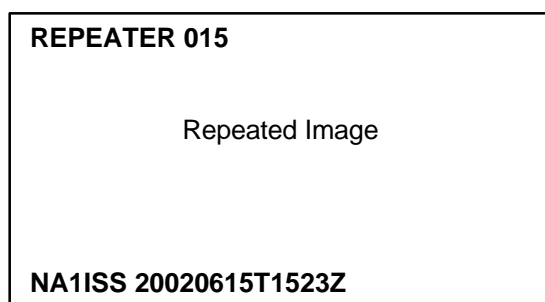
and TIMETAG is a string providing date and time of the begin of the transmission (specified in the format YYYYMMDDTHHMMZ).

**At the top-left of each repeated image SpaceCam will also superimpose the text:**

**REPEATER NNN**

where NNN is a counter ranging from 001 to 999 (the counter is incremented for each repeated image and is reset to 000 whenever the program is taken out of Repeater Mode).

Example:



#### 5.3.3.4 Additional text overlays

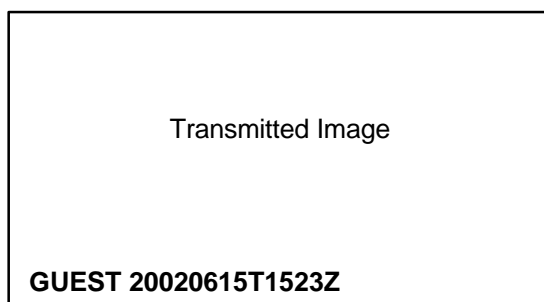
It is possible to add additional text overlays to transmitted images.

By means of the TEXT Tab panel it is possible to specify a new “guest” callsign (to substitute the default one) and/or a multi-line text message (to be superimposed in addition to the default text overlay).

By checking the Enable checkbox in the TEXT Tab, the specified overlays will be superimposed to each transmitted image in every operating mode.

The “guest” callsign, if specified, will substitute the default callsign register with SpaceCam in the bottom-left corner of the image, along with the time tag.

Example of “guest” callsign only:

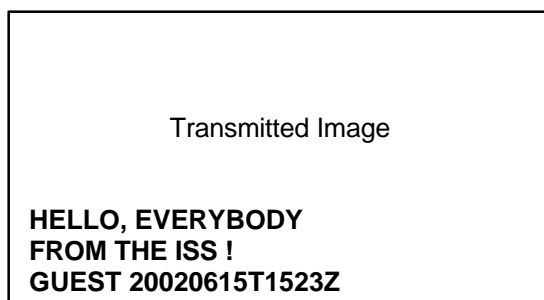


The multi-line text message is instead positioned over the image to be sent accordingly to user settings which specify the vertical and horizontal position of the overlay. If the lower-left corner is selected then the additional text will be overlaid just above the standard text information.

Example (multi-line text in the upper/centred position, no “guest” callsign):



Example(multi-line text in the lower/left position, and “guest” callsign):



## **5.4 Operating modes transitions and eligibility**

TBD

## 6 TECHNICAL DATA

### 6.1 Performance data

#### 6.1.1 Requirements

The SpaceCam software has been designed for installation on ISS Station Support Computers (IBM Thinkpads) running Microsoft's Windows.

The SpaceCam software can also be used on similar PCs equipped with SoundBlaster compatible audio cards (required) and with video frame grabber hardware (optional). The PC shall run Microsoft's operating systems, (Windows 95, Windows 98 and NT 4.0).

Laptop CPU and Memory minimum requirements:			
Operating System	CPU Speed (MHz)	RAM (Mbytes)	Video Ram (Mbytes)
Windows 95	166	48	2
Windows 98	250	96	2
Windows ME	300	128	4
Windows NT	300	128	2
Windows 2000	500	256	4

#### 6.1.2 Other requirements

##### 6.1.2.1 Hardware

TrueColor video card (16, 24 or 32 bit display)

16 bit, crystal controlled Soundcard, with appropriate drivers software

##### 6.1.2.2 Software

Memory requirements during operation	TBD
Disk requirements for full installation	TBD
Additional disk storage for images	Variable

The amount of disk space required store each SSTV image will vary depending on the amount of detail contained in the image. There is a Disk-Save feature in SpaceCam software, which will limit the amount of disk space used by the SSTV images.

#### 6.1.3 size of SSTV JPG images

Typical SSTV image sizes are as follows



Maximum	100 kbytes
Average	50 kbytes
Minimum	18 kbytes

Received images will have a resolution dependant from the SSTV mode used by the transmitting station (see Section 5.1.1) and will correspond, pixel to pixel, to the images shown in the Left-Hand Window. Transmitted images will likewise have the resolution chosen by the SSTV Mode selected by the user. When an image file is chosen for transmission, its resolution will be adapted to fit in the Left-Hand Window. In other words, transmitting a large image file will produce the transmission of a smaller, low-resolution, copy of it and not that of the original file.

#### **6.1.4 SpaceCam technology**

The SpaceCam program is a full 32 bit Windows95 ®, Windows98 ® or WindowsNT 4 ® application that couples the front panel GUI to a 'virtual' SSTV engine which is based on state of the art DSP (Digital Signal Processing) technology. The DSP engine can process SSTV images at near the theoretical limits of the SSTV signal specifications.

##### **6.1.4.1 System Highlights**

DSP VM (Virtual Machine):

- Analog signal detection provides superior performance over 'hard limited' FM detectors by permitting sub-cycle frequency recovery.
- DSP VM runs at all times to provide detector spectral display, tuning meter display, and receive autostart based on VIS or sync recovery.

##### **6.1.4.2 User Interface**

- Simple user interface, one panel to receive or transmit images.
- Most image operations are based on fast 'drag and drop' or 'single click' operations. All controls can be rapidly accessed using powerful tab function panels or single keyboard key strokes (fast keys)
- Image processing functions include AF band pass filters to assist in removing out-of-band noise from received images.
- Disk storage of images is handled by a "thumbnail" tray, which provides small preview images of files on your disk as well as instant drag and drop access to user's favourite directories.

The SpaceCam system will capture video frames for transmission from Video For Windows compliant cameras and frame-grabbing devices. These can include internal frame grabbers, USB-connected cameras, and video capture cards. The only capture devices that should be avoided, if possible, are those that attach to the parallel printer port. Generally speaking, those devices are very inefficient of CPU bandwidth, give poor video quality, and can cause operational problems with SpaceCam. If the use of a parallel port camera or capture device can't be avoided, reduce the "Frame Rate" parameter (described below) to as low a value as possible.

## 6.2 Safety considerations

Every precaution has been taken to ensure that SpaceCam will not be the source of malfunctions in the SCC.

In particular SpaceCam will not modify or delete any file present in the file system of the computer on which it is installed. Received images are stored only in predefined directories (themselves allocated within the SpaceCam application sub-tree). The only directory accessible outside the SpaceCam sub-tree is that selected as USER collection of images. Even in this case, files in the selected directory will be accessed only read-only and the access will be limited to files which are recognised to be of a standard graphical format.

This guarantee that using SpaceCam, or any other feature included in SpaceCam, will not modify sensitive portions of the file system, and that the transmission of non graphical information will not be permitted.

In addition there is no known chance that a virus may be injected into the SSC by means of uploaded video images. SpaceCam is designed to save only image files, and save them as JPG (or JPEG) files. Received signals are analogue ones, sampled and converted to a digital stream which, in turn, is formatted as a JPEG file, which cannot be an executable one. SpaceCam does not perform a computer to computer digital file transfer in any direction.

## 6.3 Stowage list

The SpaceCam software comprises:

- Software CD-ROM (includes manuals)
- VOX/SSTV Adapter Module
- VOX/SSTV Adapter Module Cable (audio cable)
- **Optional RS-232 PTT Switching and Audio Cable**

## 6.4 Software installation

### 6.4.1 Installation from scratch

The installation process is performed following these steps:

1. Close any active application on the target computer
2. Insert the SpaceCam CD-ROM and open it.
3. Double-click on Setup.exe
4. Following the instructions on the screen (it may be necessary to specify a different base directory, from the one suggested for the installation of SpaceCam program files).
5. At the end of the installation remove the CD-ROM and proceed to verify the installation (see 6.4.3).

### 6.4.2 Removing a precedent installation of SpaceCam

If SpaceCam is already present on a computer it is better to remove it before performing a new installation (i.e., for a software update). In this case follow these steps:

1. Select the Control Panel from Start -> Settings
2. Double-click on the Install/Remove Applications icon. A window will appear.
3. Scroll the list to find the SpaceCam entry. Select it.
4. Click on the Add/Remove button and confirm Yes at the following prompt.

5. The program will be removed (a few program directories containing images may be left in the file system and will require manual deletion).
6. Close the Install/Remove Applications window.

### 6.4.3 Verifying the installation of SpaceCam

If it is desired to operate SpaceCam with an external video source (video camera or webcam) please connect it to the computer before starting the program.

1. Start SpaceCam by selecting the item ISS-SCAN in the Programs list of the Start Menu.
2. An initialisation screen will appear to be substituted by the main, and only, SpaceCam window. The program is successfully running.
3. Enable the video source by selecting the relevant checkbox in the MANUAL Tab.
4. Verify that images are available in the Right Hand window.
5. Click on the Camera Grab button of the MANUAL Tab. A snapshot of the streaming video will be transferred to the Left Hand window.
6. Click on the TRANSMIT button of the MANUAL Tab. Transmission of the image will start and an audio tone will be heard from the computer speaker.
7. The system is ready to operate and to be connected to the radio system.

#### Warning

Always install and test the drivers for the video source (camera or webcam) before running SpaceCam with Enable Video selected.

## 6.5 Hardware installation

The SSC (IBM-760) computer running SpaceCam will be connected to one of the two SAREX (2-meter or 70cm) transceivers via the SSTV/VOX Adapter Module (see also 6.7.1).

The complete set of connections will require two (2) cable attachments to the SSC using existing connectors on the SSC as follows:

- Audio Output: 1/8 stereo connector attached to the SSC audio line-level output connection.
- Audio Input: 1/8 stereo connector attached to the SSC microphone input connection.

A three (3) cable attachment arrangement is required if the SSTV/VOX Module VOX function is not available and transmitter keying is to be provided via the SSC serial port. In this case an additional cable is required:

- Transmit Control: Serial cable terminated with a DB-9F attached to the SSC serial port.

The two or three SSC computer connections will then feed into the SSTV/VOX Module and from thence to the radio equipment. The SSTV/VOX Module will provide DC isolation between the SSC and the SAREX transceiver. The SSTV/VOX Module will also convert the SSC serial cables (RS-232 DTR) signal into a transmit control signal which is compatible with the SAREX transceivers.

### 6.5.1 Connections checklist

#### TBP

1. Un-stowing the necessary items

2. Connecting the various parts
3. Powering the various parts
4. Firing it up
5. Detaching the various parts
6. Stowing everything

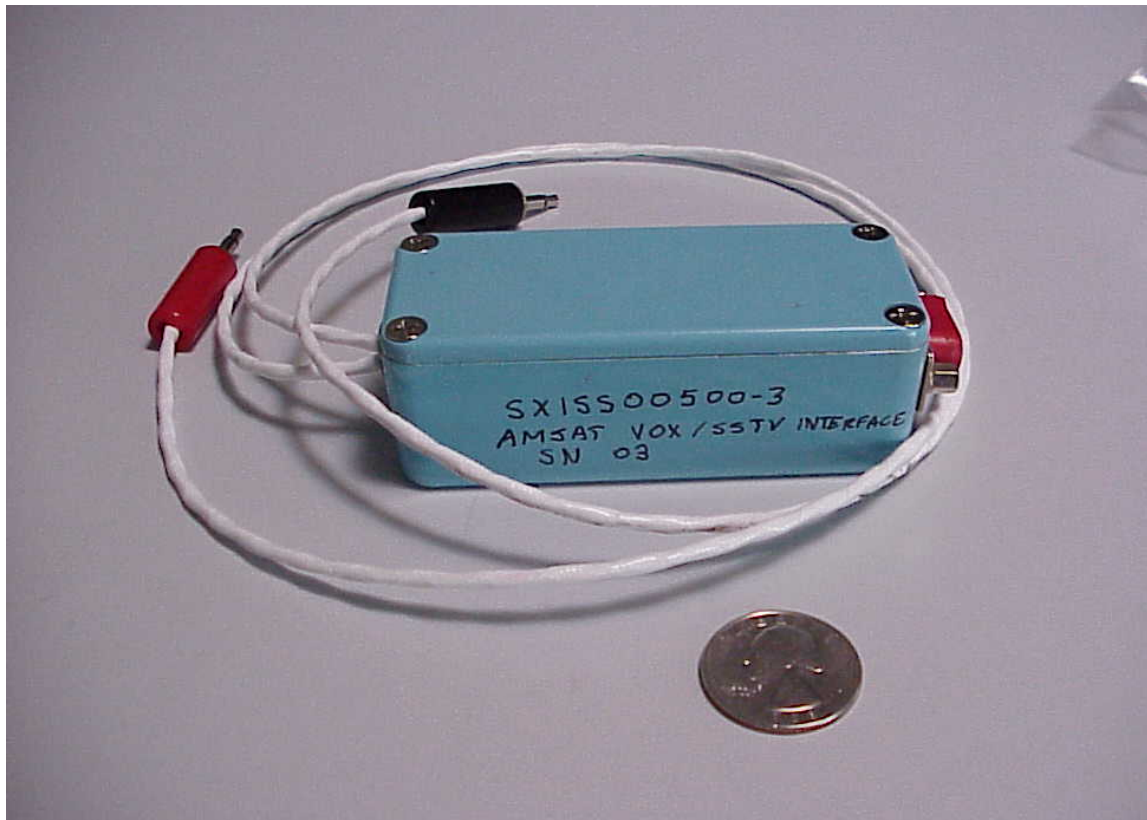


Figura 6.1: SSTV/VOX Module prototype.

## 6.6 Software configuration

### 6.6.1 Files and directories

After installation in the SpaceCam base directory (from thence assumed to be "C:\Program Files\ISS-SCAN"), the following files/directories will be part of the application:

<b>C:\Program Files\ISS-SCAN\</b>	<i>Installation directory</i>
<b>CREW\</b>	<i>CREW Image collection</i>
<b>DEFAULT\</b>	<i>DEFAULT Image collection</i>
<b>LIBRARY\</b>	<i>LIBRARY Image collection</i>
<b>REPEATED\</b>	<i>REPEATED Image collection</i>
<b>ISS-SCAN.exe</b>	<i>SpaceCam application program</i>

**ISS-SCAN.INI***SpaceCam configuration file***OVERLAY.TXT***SpaceCam configuration file*

The 4 directories are associated to the relevant image collections and will be used to contain images. User can manually edit the content of these directories.

For each image in the directories corresponding to the five collections, SpaceCam will generate a preview image (file extension is .PRE) corresponding to the small “thumbnail” image shown in the relevant tray. These images are very small, typically 10 Kbytes in size.

The last two files are discussed in the next paragraph.

## 6.6.2 Configuration files

### 6.6.2.1 ISS-SCAN.INI configuration file

This file contains various parameters. Most of them are managed by the program itself and shall not be modified.

The file is divided in sections.

Parameter	Default Value	Notes	Man. Modif.
<b>GENERAL section</b>			
RxSampleRate	11025,00	SSTV Receiver sampling rate	No
TxSampleRate	11025,00	SSTV Transmitter sampling rate	No
PTTPort	0	COM port used for transmitter keying while not in VOX Tx control (0 is for VOX Tx control)	Yes
PTTRTS	False	If PTTPort > 0 selects the RTS signal to control PTT keying (alternative to PTTDTR)	Yes
PTTDTR	False	If PTTPort > 0 selects the DTR signal to control PTT keying (alternative to PTTRTS)	Yes
<b>PREFERENCES section</b>			
AutoSave	True	State of the Auto Save check box at program startup	No
ModeLock	False	State of Mode Lock check box at program startup	No
Video	False	State of Video Enable checkbox at program startup	Yes
DSPFilter	3	DSP Filter option selection (0 to 3)	No
Sensitivity	3	SSTV Receiver sensitivity setting	No

Parameter	Default Value	Notes	Man. Modif.
Sharpness	4	DSP sharpness setting	No
FrameRate	15	Video source acquisition frame rate	Yes
UserPath	“...”	Full pathname to user selected directory for the USER image collection	No
SlideShowDelay	1	Delay between subsequent Slide Show Mode transmissions	No
HFMode	False	Dedicated setting for ground based HF operations	Yes
VideoDevice	0	ID of the video capture device	Yes
<b>TEXT section</b>			
GuestCallsign		Additional guest operator callsign	No
Overlay	False	State of the text Overlay Enable checkbox	No
Vertical	Center	Selection from the text vertical position radio buttons	No
Justification	Center	Selection from the text horizontal position radio buttons	No

#### 6.6.2.2 OVERLAY.TXT configuration file

This file contains the text of the additional optional multi-line message to be superimposed on transmitted images.

## 6.7 Additional technical information

### 6.7.1 Transmitter Control

The SpaceCam1 supports both PC Serial Port transmitter control and Voice/Audio switching (VOX). The Configuration File of SpaceCam allows the user to select between the two modes of operation. Only one mode can be selected at a time.

If the Serial TX control is selected the user can switch between different serial ports and choose between DTR and RTS signal leads (only one of the two) to act as PTT lines for the transceiver.

If the VOX option is selected an external device, the SSTV/VOX Module attached to the audio cables of the PC, will perform the transmit/receive switching. The VOX circuit relies on hearing audio from the PC to control when the transmitter will be activated. Because there are inherent delays in activating the VOX circuit and then the transceiver and the waiting for the transceiver to reach full power, SpaceCam sends a wake up tone (in the transmission

preamble before the CW ID) to the VOX device. Without the wake up tone, it may be possible that part of data being sent by SpaceCam is lost.

### 6.7.2 VOX Operations

The VOX device will be activated by the DTMF character '#' symbol. The tone will be generated for approximate 1000 milliseconds. This should allow enough time for the VOX sensors to detect the tone and send the commands to cause the transceiver to begin transmitting. Most transceivers require 300 - 500 milliseconds to switch from the receive mode to transmit mode and establish full power. In theory the transceiver should be at full power transmit mode before the first letter of the CW ID is sent from SpaceCam. The VOX circuit will continue to maintain the transmit mode as long as there is an audio stream present.

#### Note

A time-out circuit built into the VOX hardware will cause the VOX to shutdown TX commanding of the transmitter if this is already active since more than 5 minutes of continuous operation.

The VOX circuit will stop commanding a transmission after a loss of audio lasting between 2-3 seconds.

The following table summarises the timings for VOX operations.

Start Tone DTMF #	1000 msec	Adjustable 500 - 2000 ms
Delay before CW ID	1000 msec	Adjustable 500 - 2000 ms
CW ID		Fixed
Delay after CW ID	1000 msec	Adjustable 500 - 2000 ms
SSTV Sync pulse		Depends on SSTV mode
SSTV data	35 - 90 sec	SSTV mode dependant
Delay after image (no Audio)	2000 msec	Fixed

The delay settings will default to values chosen during final hardware/software test integration. In case of need the user can adjust the values. New values will be saved until changed again or reset to default values.

### 6.7.3 Serial port operations

The serial port DTR (or RTS) signal will be set **High (Active)** during all SSTV transmission sessions and set **Low (Inactive)** during SSTV receive modes and during stand-by.

The transceiver interface will be expected to track the status of the DTR (or RTS) signal to control the transceiver mode. The delay before CW ID should be long enough for the transmitter to reach full power. Most transceivers require 300 - 500 milliseconds to switch from the receive mode to transmit mode and establish full power. In theory the transceiver should be at full power transmit mode before the first letter of the CW id is sent from SpaceCam. The DTR signal will continue to indicate the transmit mode as long as it is

required by SpaceCam. The DTR signal will be set low to signal the transceiver interface to switch back to receive mode.

The following table summarises the timing for serial port operations (DTR selected as source of the PTT signal).

DTR signal goes High		
Delay before CW ID	500 ms	Adjustable 500 - 2000 ms
CW ID		Fixed
Delay after CW ID	1000 ms	Adjustable 500 - 2000 ms
SSTV Sync pulse		Depends on SSTV mode
SSTV data	35 - 90 sec	SSTV mode dependant
Delay after image	????	Adjustable 1000 - 2000 ms
DTR signal goes Low		

The delay settings will default to values chosen during final hardware/software test integration. In case of need the user can adjust the values. New values will be saved until changed again or reset to default values.

#### 6.7.4 Repeater access control

Ground stations access the SSTV system in Repeater Mode by sending for 2 seconds or more a fixed frequency tone. Tone requirements are:

- Frequency: 1750hz +/- 100hz for 2 seconds or longer
- Distortion: Less than 10%
- Signal to Noise ratio:  $\geq 18\text{db S/N}$  ( $\text{S/N} \times \text{ABOVE}$  internal noise)

#### 6.7.5 Dedicated settings

This paragraph describes how to set the different controls related to audio levels, DSP filter characteristics and the like.

##### To Be Provided

Maybe redundant. See 5.3.



## 7 CREDITS

SpaceCam contains portions of software copyrighted by Silicon Pixels.

All other brand names and trademarks which appear in this document belongs to their respective owners.

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